Low Energy Events in

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MicroBooNE Collaboration

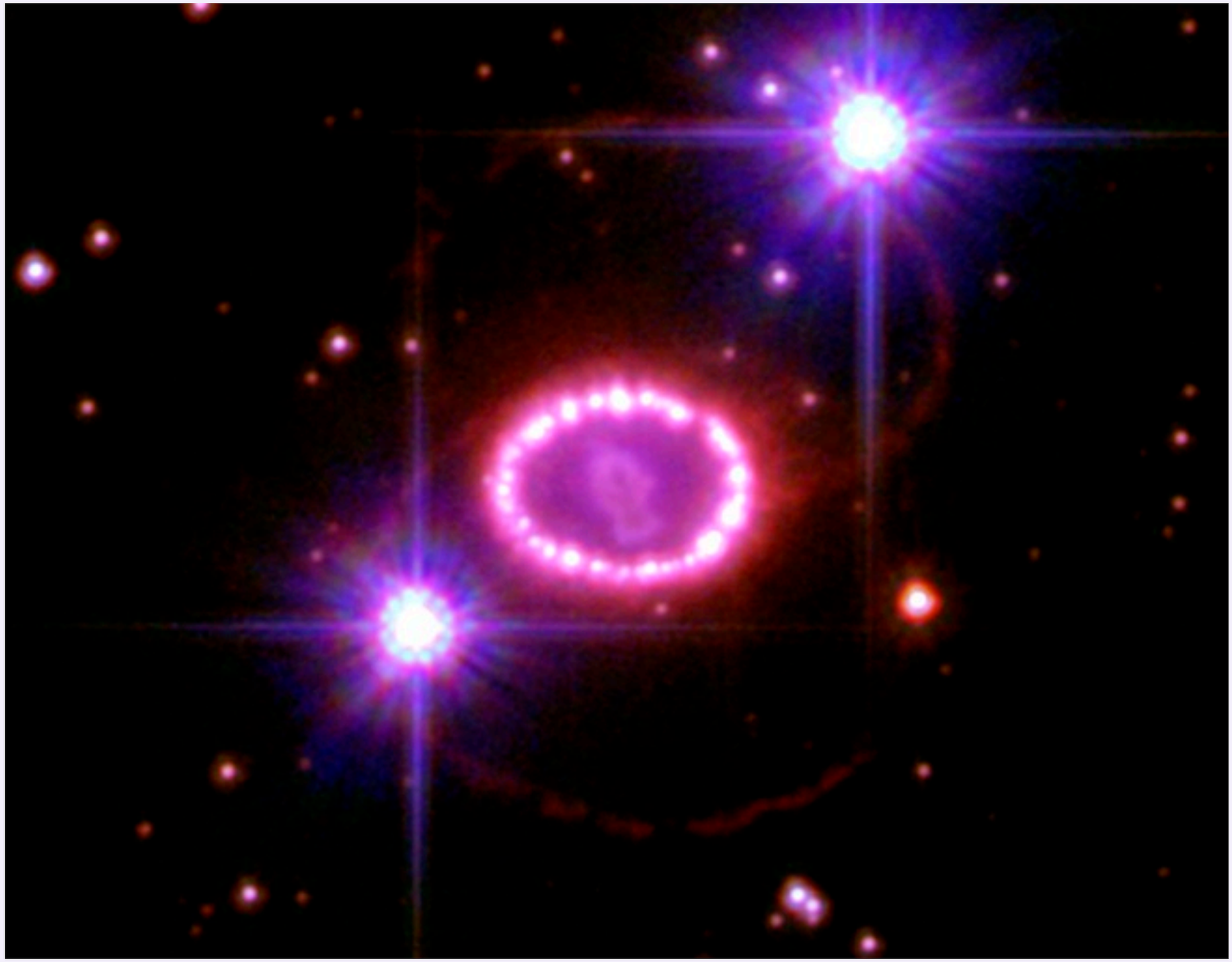
July 11, 2013

Feel free to interrupt with questions.

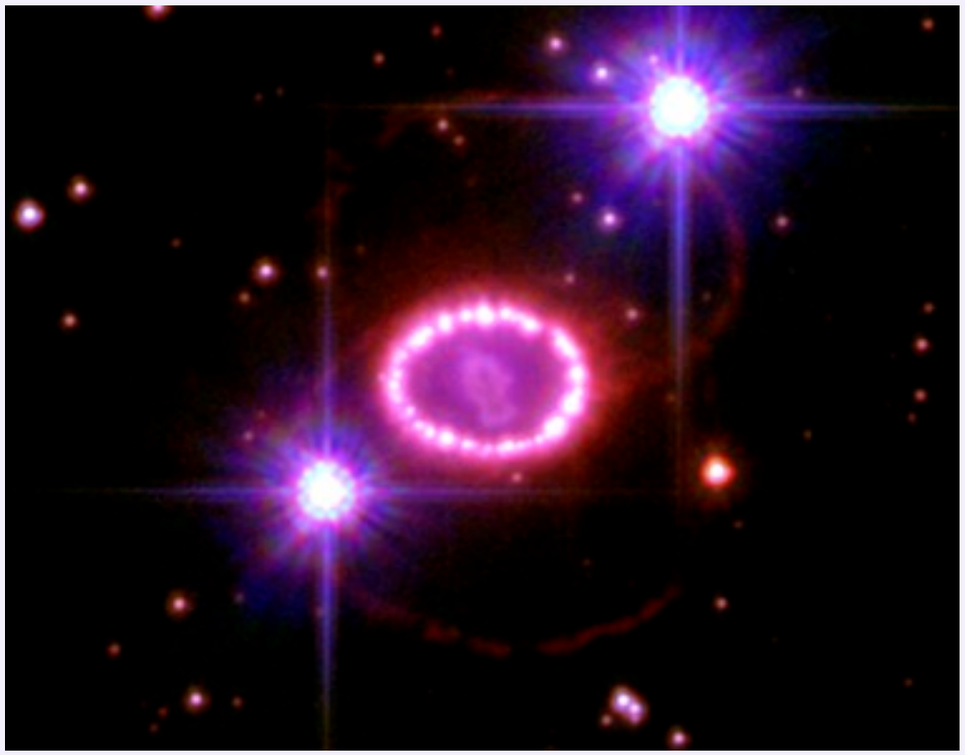
Sources of Low Energy Events

- Supernova Neutrinos
- De-excitation Gammas
- Intrinsic Backgrounds: Ar_{39} et al.
- (Plus others I won't mention.)

Supernova Neutrinos



Supernova Neutrinos



SN1987A
51.4 kpc away in the Large Magellanic Cloud
(Closest to Earth since 1604)

Core Collapse supernovae release a LOT of energy.

(Different from the "standard candle" supernova from dark energy searches)

Emits a LOT of neutrinos

Why care about SN Neutrinos?

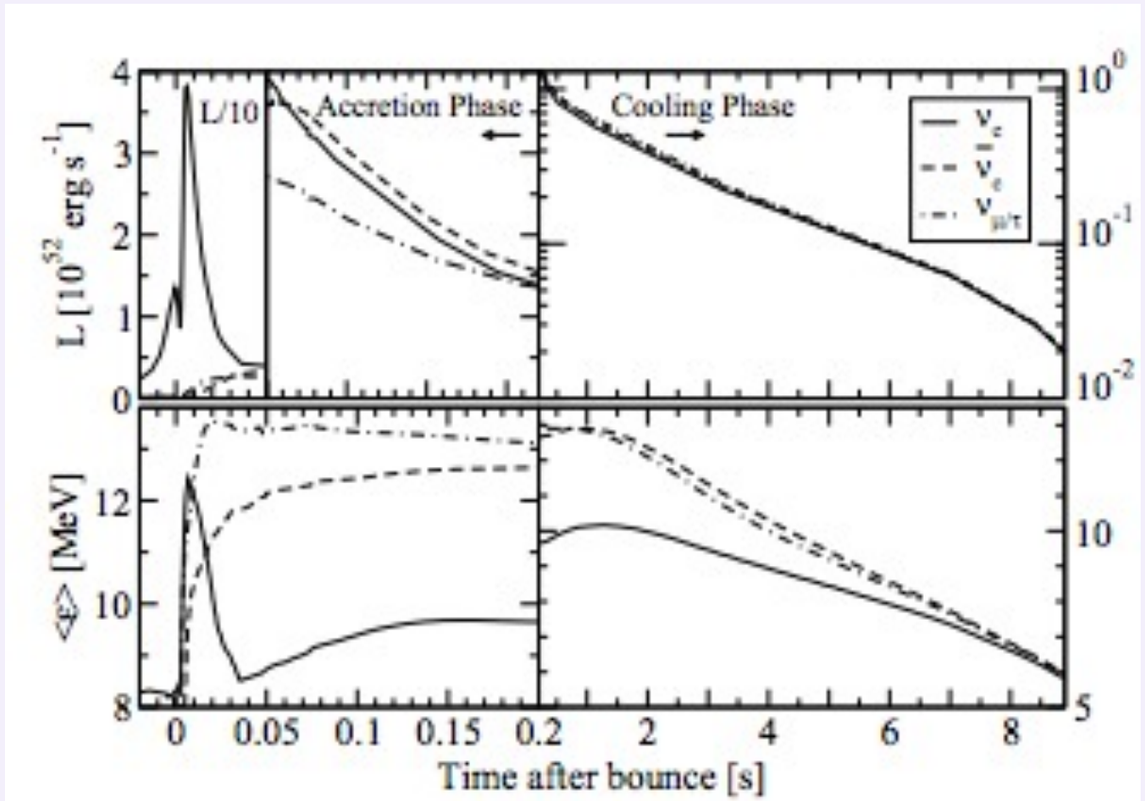
Neutrino Physics

- Determine the mass heirarchy?
- Effects of Oscillation?

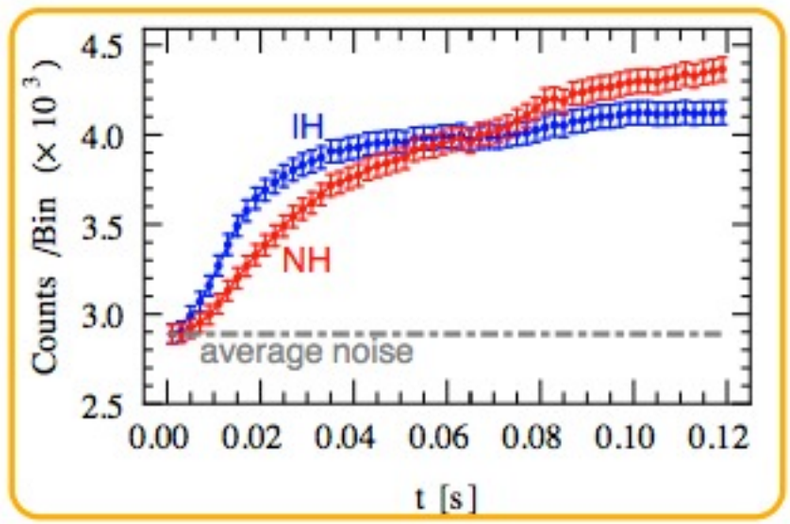
Supernova Physics

- Distance to the supernova?
- Probe of supernova models through the time and energy spectra of neutrinos

Time Signature of Events



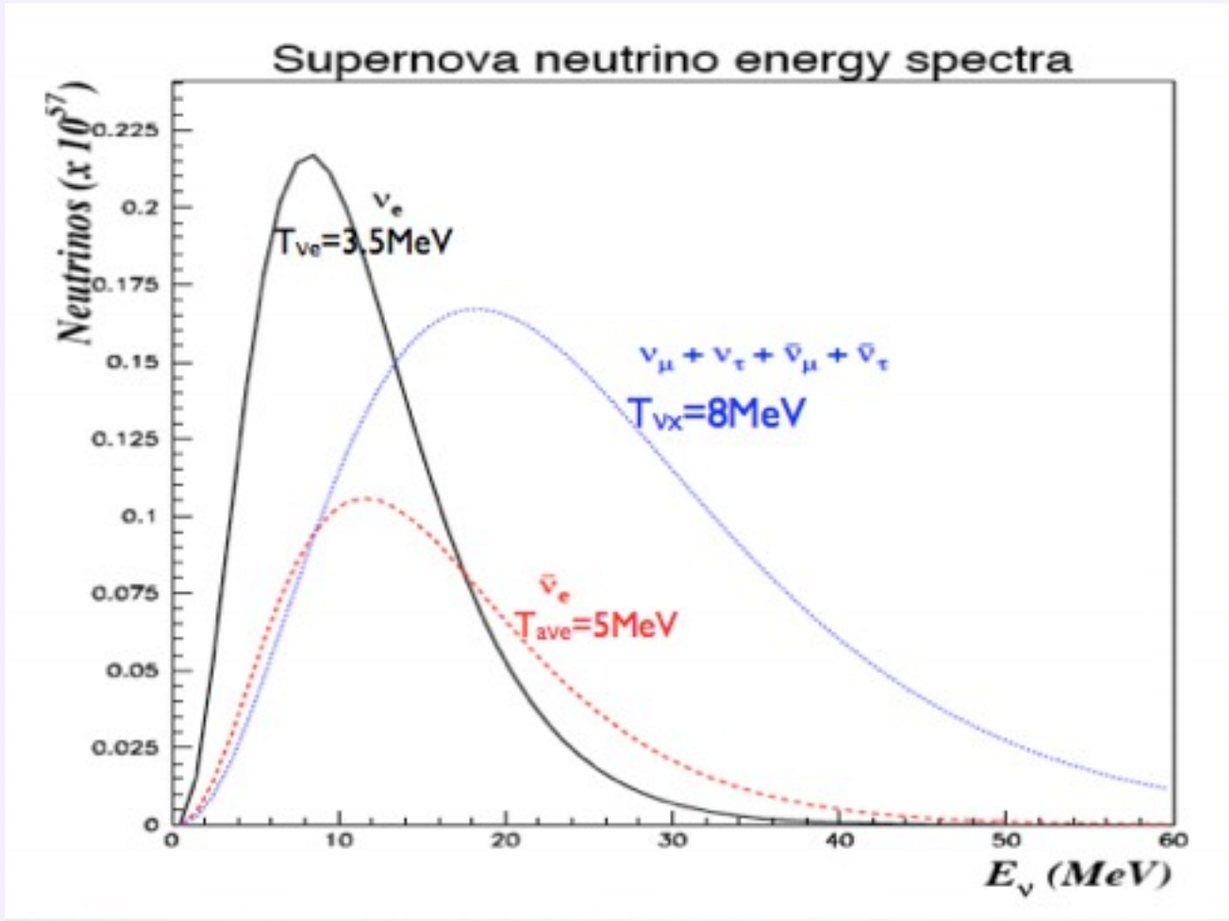
Neutrino signal of electron-capture supernovae from core collapse to cooling
L. Hudepohl et al.
http://arxiv.org/pdf/0912.0260v3.pdf



The rise-time in IH is always faster than the NH one!

I. Tamborra (Max Planck Institute, Munich)
Presentation to MicroBooNE R&D Group

Supernova Spectrum



*F. Cavanna

With large theta13, there is total conversion to electron neutrinos from mu, tau.

Bottom line: we expect supernova neutrinos to be around ~20 MeV.

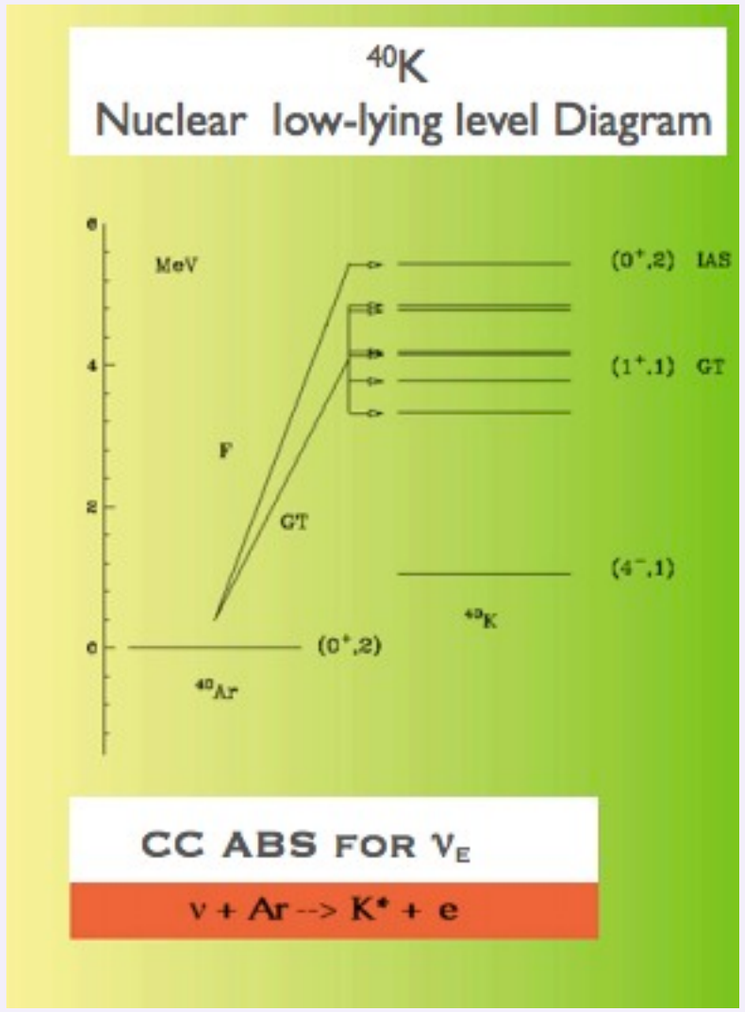
Supernova Events in uBoone

How many events will we see?

Rate is: Flux * CrossSection * Detector Size

$$\nu_e + Ar \rightarrow K^* + e^-$$

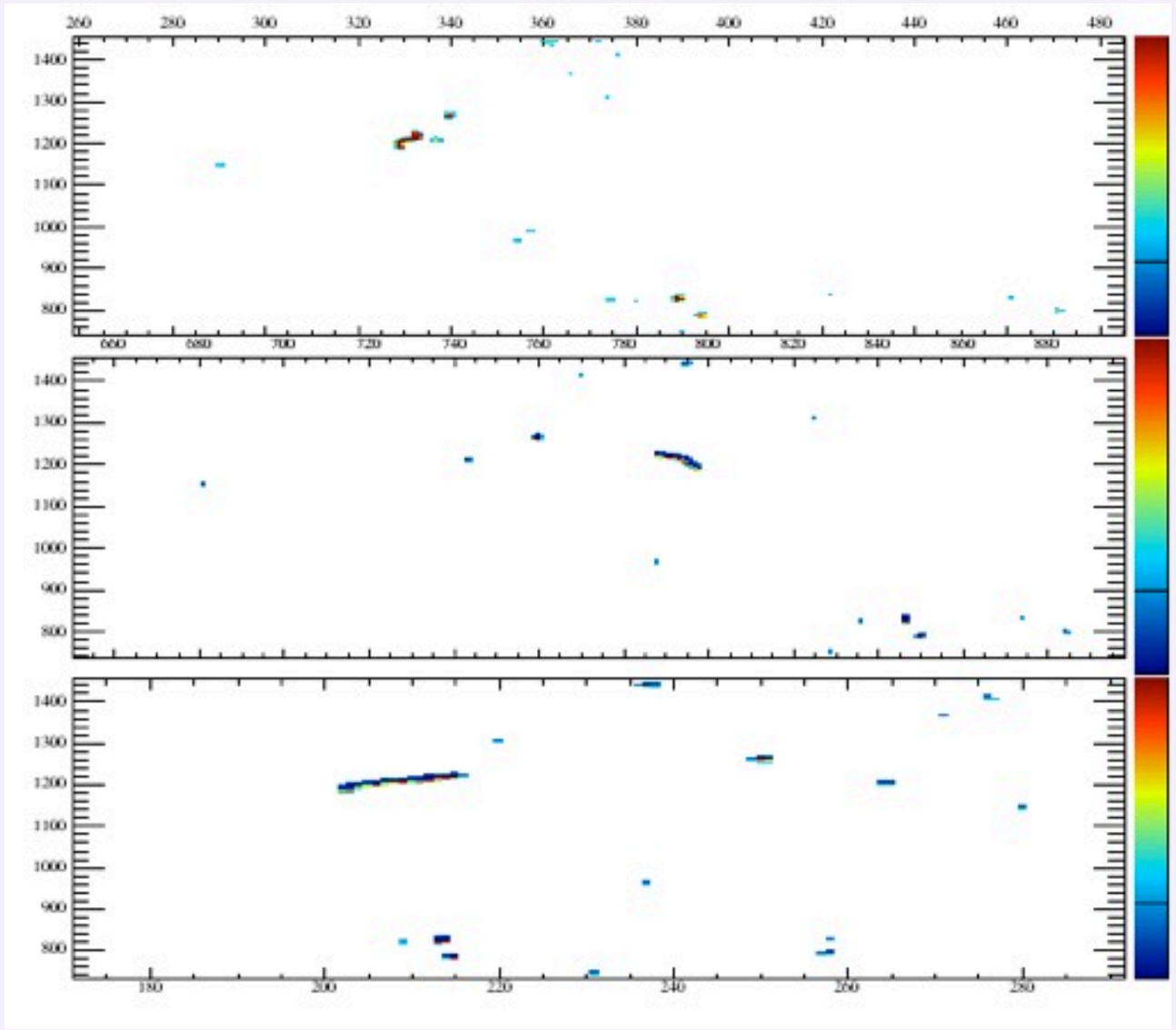
(Charged Current Absorption)



*F. Cavanna

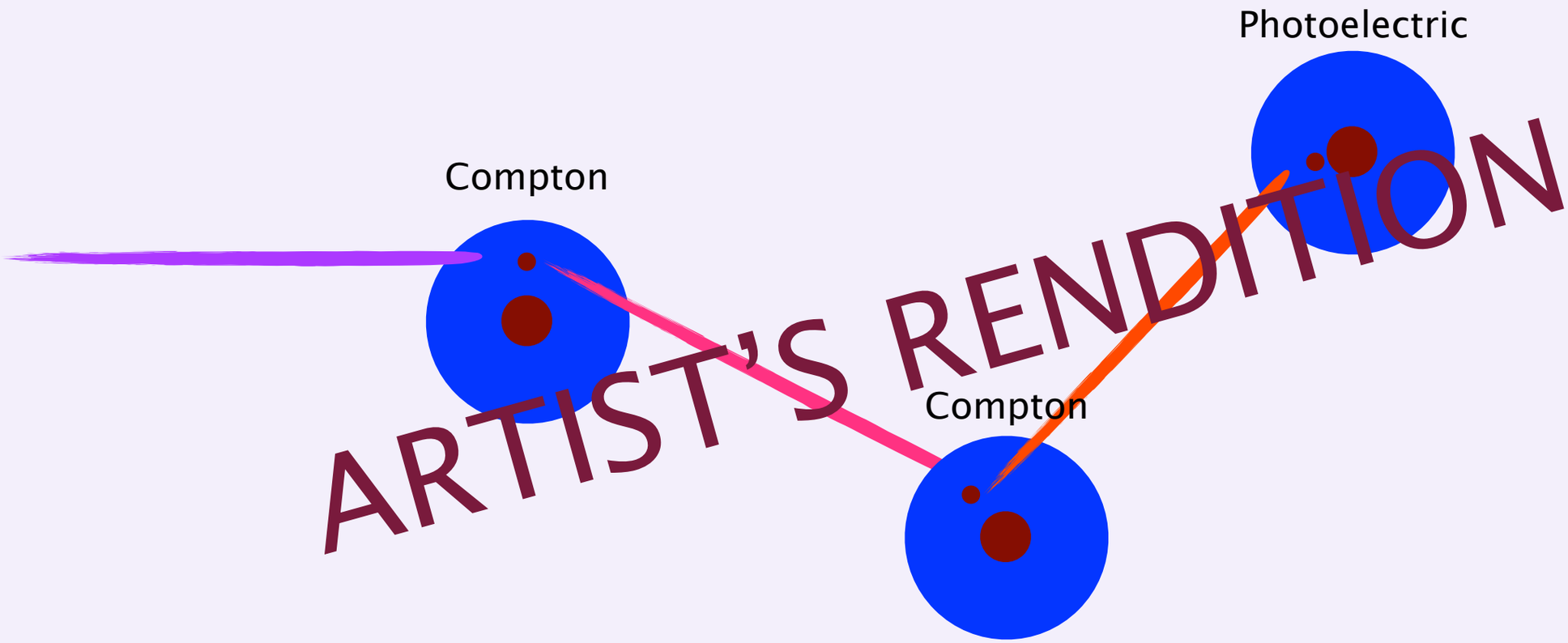
At supernova energies, in MicroBooNE, we expect to see 15-30 neutrino absorption events from a galactic supernova.

Events in the Detector



- Expected signature: a short but extended electron track, plus several small, one or two hit “tracks” from the de-excitation of the nucleus.

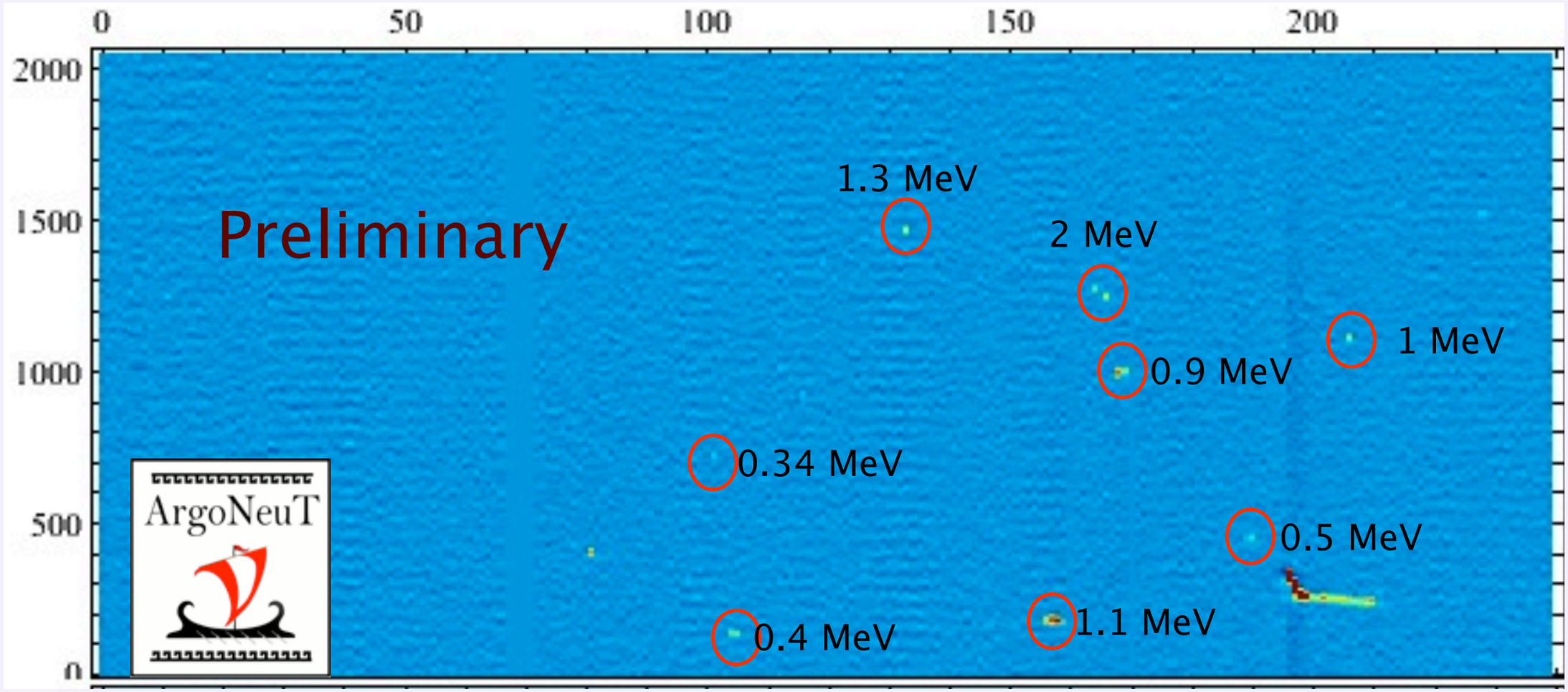
De-excitation Gammas



The gammas give energy to electrons as they travel through the argon, can interact via:

- Compton Scattering
- Photoelectric Effect

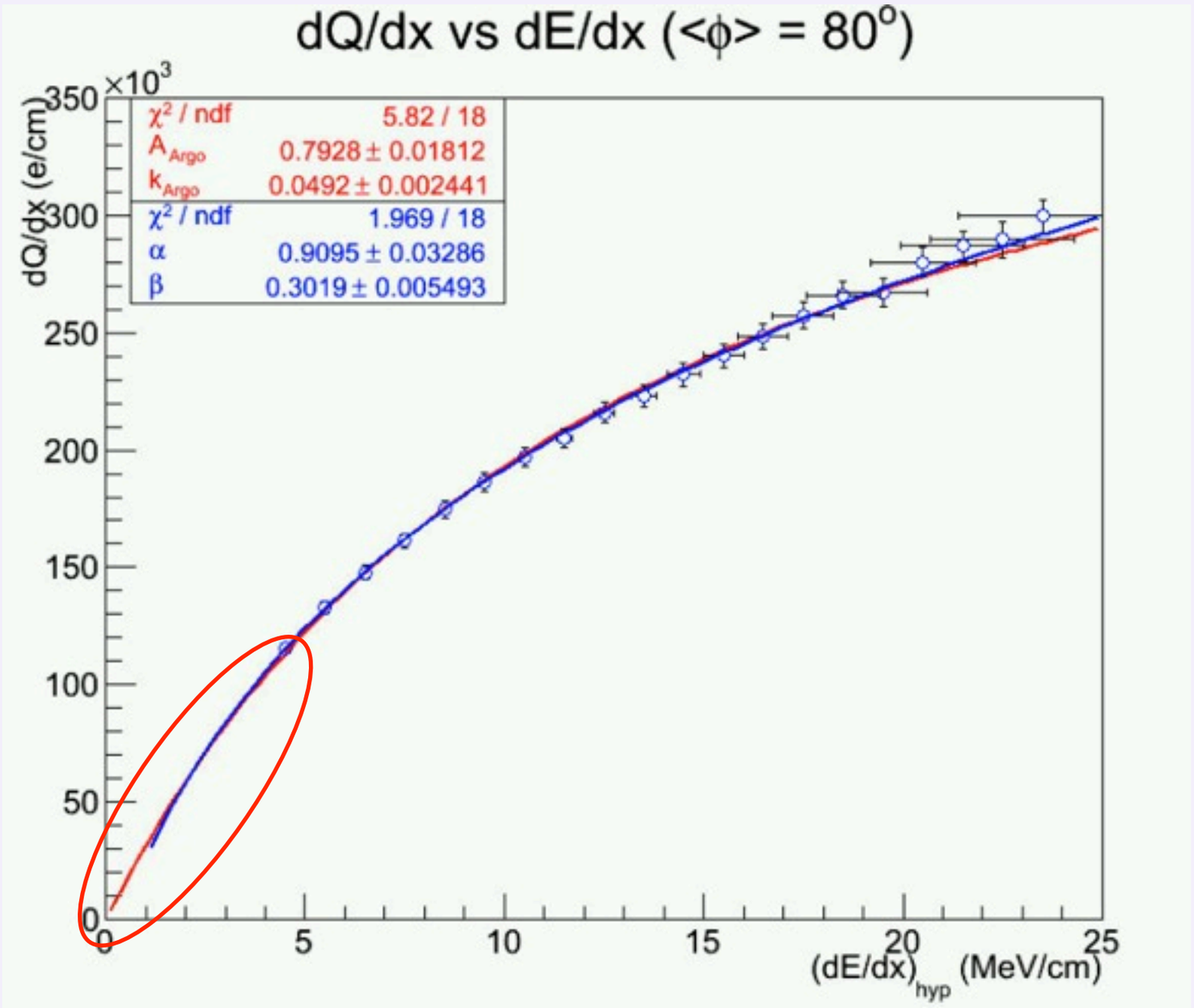
De-Excitation Gammas in



Can have multiple gammas, each can have multiple interactions.

Further complication: there are other particles that can have similar signatures!

Reconstructing Low-E



ArgoNeuT Collaboration, B. Baller et. al
http://arxiv.org/abs/1306.1712

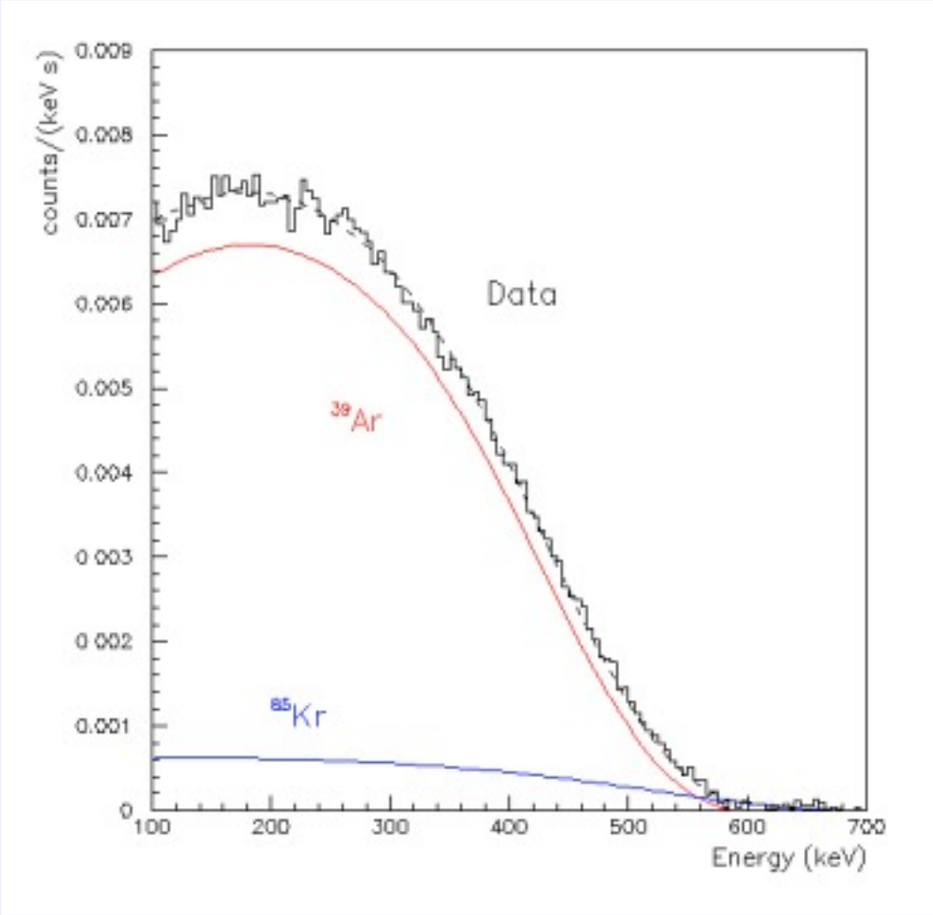
With tracks that are shorter than a wire spacing, how do we know dx?

Use the track pitch as dx, and calculate dE. In the linear region, this ought to give the real dE up to some calibration...

Argon 39

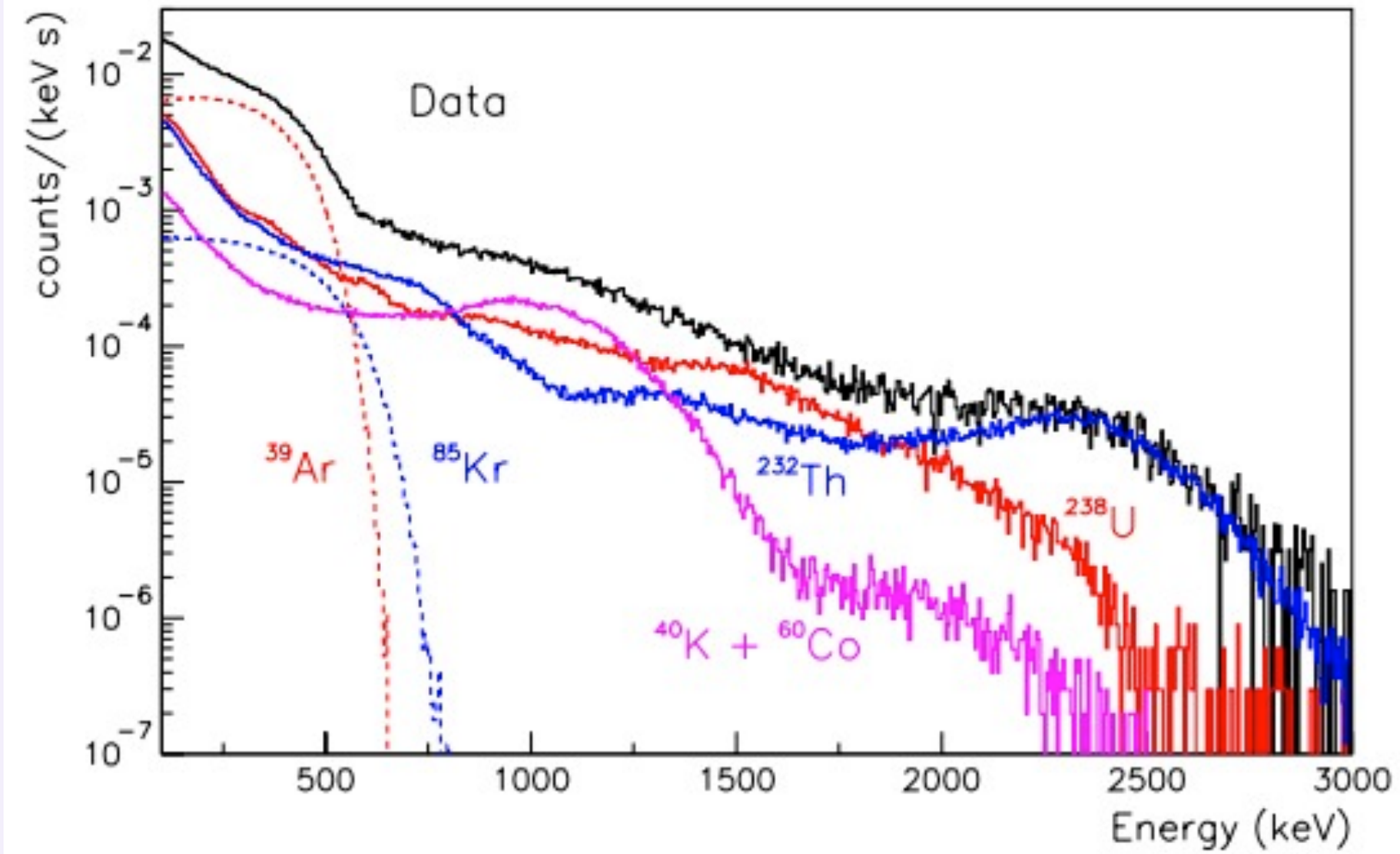
- How do we know we are getting this right?
- **Need some low energy calibration.** Argon 39 beta decay is an excellent candidate to

$$^{39}Ar \rightarrow ^{39}K + e^{-} + \bar{\nu}_e$$



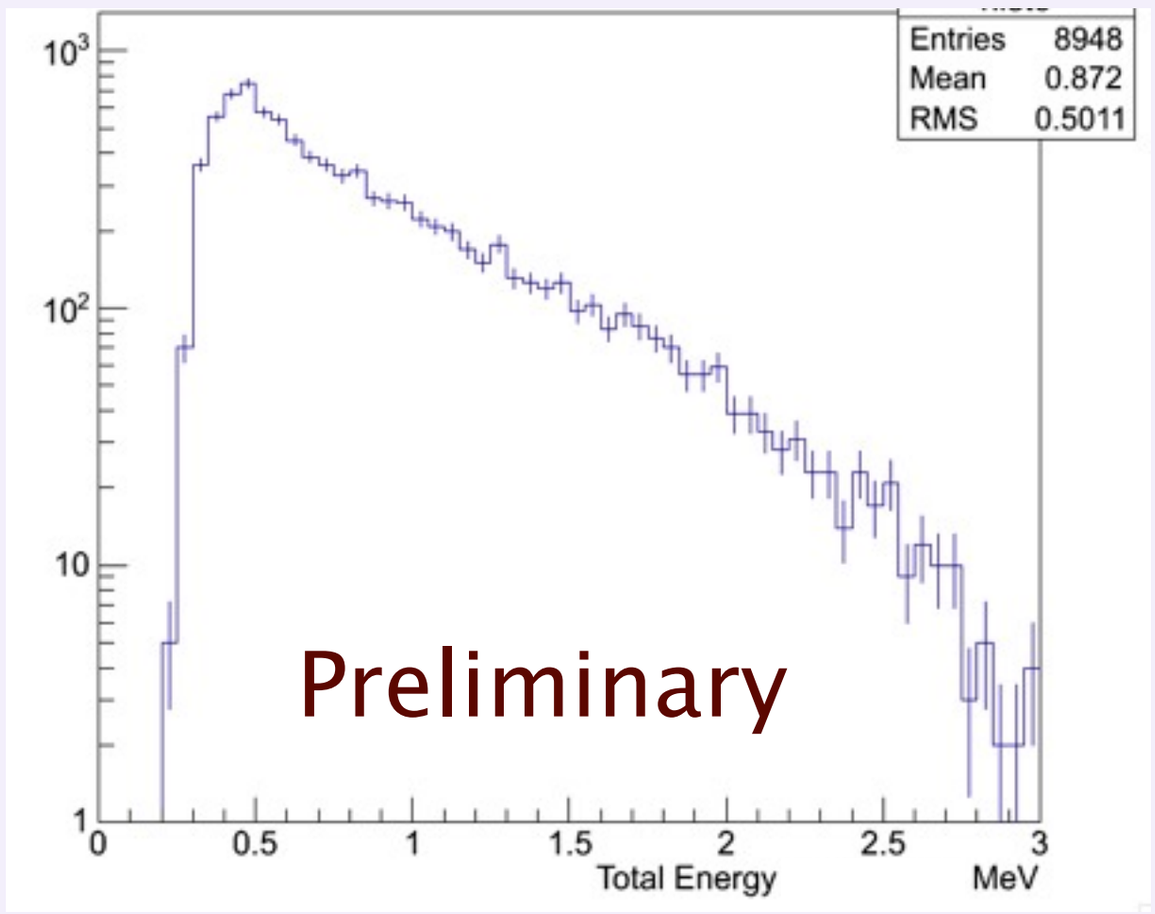
WARP Collaboration, **Measurement of the specific activity of 39Ar in natural argon**

Backgrounds in Liquid Ar

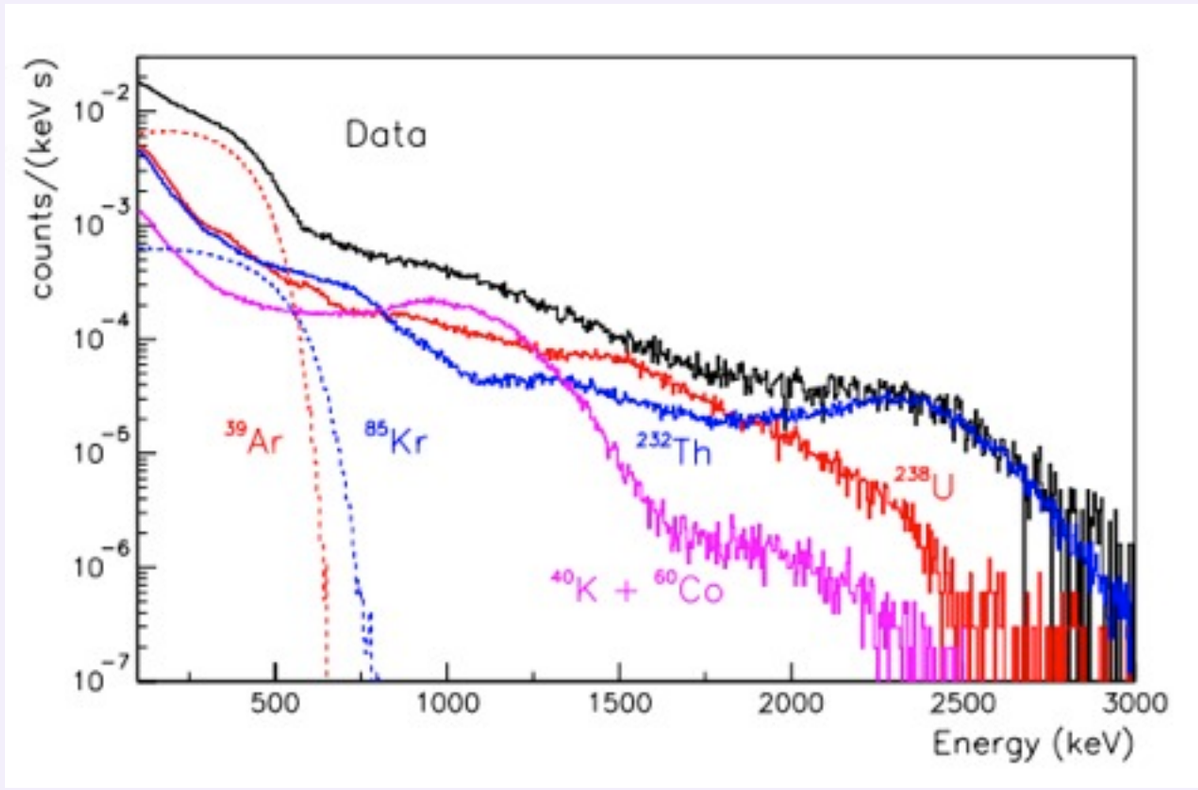


WARP Collaboration, **Measurement of the specific activity of 39Ar in natural argon**
http://arxiv.org/pdf/astro-ph/0603131v2.pdf

Argon 39 (?) in ArgoNeuT



ArgoNeuT Data



WARP Data

Our prospects of seeing these interactions in MicroBooNE

Will we see a supernova?

I hope

List of supernova candidates

From Wikipedia, the free encyclopedia

This is a **list of supernova candidates**, or stars that astronomers have suggested are supernova progenitors. Type II supernova progenitors include stars with at least 10 solar masses that are in the final stages of their evolution. (Prominent examples of stars in this mass range include Antares, Spica,[1] Gamma Velorum,[2] Mu Cephei, and members of the Quintuplet Cluster.[3]) Type Ia supernova progenitors are white dwarf stars that are close to the Chandrasekhar limit of about 1.38 solar masses and are accreting matter from a binary companion star. The list includes massive Wolf–Rayet stars, which may become Type Ib/Ic supernovae.

This is an incomplete list, which may never be able to satisfy particular standards for completeness. You can help by expanding it with reliably sourced entries.

Supernova progenitor candidates

Identifier	Epoch J2000		Constellation	Distance (light years)	Spectral class	Notes
	R. A.	Dec.				
IK Pegasi	$21^h\ 26^m\ 26.7^s$	+19° 22′ 32″	Pegasus	150	A8m:/DA	[4][5]
Alpha Lupi	$14^h\ 41^m\ 56^s$	−47° 23′ 17″	Lupus	550	B1.5	[6]
Antares	$16^h\ 29^m\ 24^s$	−26° 25′ 55″	Scorpius	600	M1.5Iab-b	[7]
Betelgeuse	$05^h\ 55^m\ 10.3^s$	+07° 24′ 25″	Orion	640	M2Iab	[1][8]
Gamma^2 Velorum	$08^h\ 09^m\ 32.0^s$	−47° 20′ 12″	Vela	800	WC8	[9]
Pi Puppis	$7^h\ 17^m\ 08^s$	−37° 05′ 51″	Puppis	1,100	K3 Ib	
119 Tauri	$05^h\ 32^m\ 12.8^s$	+18° 35′ 40″	Taurus	1,700	M2Iab-Ib	
RS Ophiuchi	$17^h\ 50^m\ 13.2^s$	−06° 42′ 28″	Ophiuchus	1,950–5,200	M2III/D	[10][11]
T Coronae Borealis	$15^h\ 59^m\ 30.2^s$	+25° 55′ 13″	Corona Borealis	2,000	M3III/D	[12]

Wikipedia has some

SNEWS: SuperNova

- Super K
- IceCube
- LVD
- Borexino

Will we see a de-excitation

Yes.

Plenty.

Will we see a Argon 39?

Maybe.

The cosmic backgrounds in MicroBooNE could be challenging.

ArgoNeuT expects an event once every ~30 frames. Scale to MicroBooNE volume: ~10 events per frame.

Can we spot it over the background?

Summary

There are plenty of interesting physics opportunities at the lowest end of our detector resolution!

More Questions?